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ABSTRACT

This document reviews significant developments in the labor mobility literature, with application to the large and rather special labor market for elementary and secondary teachers. To explain the mobility of teachers among schools, school districts, and between the school sector and other sectors of the economy, a framework is constructed based on the work of economists on human capital, internal labor markets, and Markov models. The intention is to show how the tools these economists have developed provide a theoretical structure that is general and comprehensive, and that researchers can draw upon in conducting empirical studies of labor markets for teachers, as well as other markets possessing similar institutional structures. (Author)

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THEORIES OF TEACHER MOBILITY

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David H. Greenberg and John McCall[1]

INTRODUCTION

Individual job choice and the selection of new employees by entrepreneurs are much studied topics in labor economics. Economists explain wage rates, quit rates, layoffs, and hires by the simultaneous interaction of job search (labor supply) and the search for employees (labor demand). The purpose of this paper is to review some of the more significant developments in the labor mobility literature and apply them to a large and rather special labor market--the market for elementary and secondary teachers.[2]

The mobility of teachers among schools, among school districts, and between the school sector and other sectors of the economy can be fully understood only by unraveling a complicated web of social, psychological, economic, and purely random components. Any theory so extravagant as to attempt a complete explanation of teacher mobility would possess a structure as complicated as the phenomena to be understood. However, an extremely simple theory with a parsimonious structure would probably yield an inadequate explanation of teacher mobility. The framework presented here aims at a balance between simplicity of structure and power of explanation by bringing to bear the work of economists on human capital, internal labor markets, and Markov models. Our intention is to show how the tools these

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[2]Much has been written on labor mobility and this paper is certainly not to be construed as a comprehensive survey. Instead, we review only those parts of the literature that seem especially germane to the explanation of teacher mobility.

economists have developed provide a theoretical structure that is sufficiently general and comprehensive that researchers can draw upon relevant portions of it in conducting empirical studies of labor markets for teachers.[1] Although the theoretical framework developed here is oriented toward teacher personnel systems, it is nevertheless quite general and should be applicable to other labor markets possessing similar institutional structures, such as those found throughout the civil service sector.

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[1]We have already used the framework in conducting two such studies. See David Greenberg and John McCall, *Analysis of the Educational Personnel Systems: I. Teacher Mobility in San Diego*, The Rand Corporation R-1071-HEW, January 1973; and David H. Greenberg and John J. McCall, *Analysis of the Educational Personnel System: VII. Teacher Mobility in Michigan*, The Rand Corporation, R-1343-HEW, October 1973.

INTERNAL LABOR MARKETS

Clark Kerr was the first of modern day writers to introduce the concept of an internal labor market, a refinement of the principle of "noncompeting groups."

> Labor markets are of two broad types: (1) the structureless and (2) the structured. In the structureless market, there is no attachment except the wage between the worker and the employer. No worker has any claim on any job and no employer has any hold on any man. Structure enters the market when different treatment is accorded to the "ins" and to the "outs." In the structured market there always exists (1) the internal market and (2) the external market. The internal market may be the plant or the craft group, and preferment within it may be based on prejudice or merit or equality of opportunity or seniority or some combination of these. The external market consists of clusters of workers actively or passively available for new jobs lying within some meaningful geographical and occupational boundaries, and of the port or ports of entry which are open or are potentially open to them.... The more structured the market, the more precise will be the rules on allocation of opportunity within the internal market and the fewer will be the ports of entry and the more rigid will be the requirements for admission.[1]

The internal labor market concept has been used to analyze the mobility of workers across industries, across firms in a particular industry, and across jobs in a specific firm.[2] Kerr identifies three different types of internal labor markets: "open," "manorial," and "guild."[3] The open market is unstructured and competitive; all job openings are filled directly from the external labor market. Manorial markets emphasize vertical stratification. Entry into this market is confined to the lower job classifications, and movement within the market takes place along a job ladder. Guild markets are

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[1]Clark Kerr, "The Balkanization of Labor Markets," in E. Wight Bakke et al., *Labor Mobility and Economic Opportunity*, Technology Press, Cambridge, 1954, pp. 101-102.

[2]See P. B. Doeringer and M. J. Piore, *Internal Labor Markets and Manpower Analyses*, D. C. Heath, Lexington, Mass., 1971, and references therein; and A. Alexander, *Income Experience and the Structure of Internal Labor Markets*, The Rand Corporation, P-4757, January 1972.

[3]See Kerr, 1954, p. 105.

stratified horizontally. Admission into the guild system tends to be closely controlled through training and other requirements, and workers tend to be highly skilled. Once a worker has the proper credentials to enter the guild, however, he is able to move relatively freely from one job to another.

In a formal sense, educational personnel systems appear to closely approximate the guild model. Although some teachers do move up a promotional ladder, most movements are lateral, from one teaching assignment to another.[1] In developing his schema, Kerr was primarily interested in nonprofessional workers. He predicted that workers within a guild would move relatively freely from firm to firm. The analogous situation within the teaching profession as a whole is movement among school districts. The analogous situation within a single school personnel system is movement among teaching assignments or schools.

Although internal labor markets for teachers are formally similar to Kerr's description of the guild system, these markets may contain important manorial elements. It seems reasonable to expect teachers, like other workers, to flow toward jobs that offer the highest pecuniary and nonpecuniary returns. For teachers, pecuniary returns are measured in terms of salary. However, since teaching assignments within a single district seldom vary by salary, pecuniary differences are usually important only in a consideration of inter-district, as opposed to intra-district, mobility. Nonpecuniary returns should affect intra-district, as well as inter-district, mobility. They may depend on such factors as a teaching assignment's geographic location and physical facilities and the characteristics of its students--their socioeconomic background, attitudes, cognitive ability, and racial composition. To the extent that new teachers are initially located in assignments ranked near the bottom of an informal hierarchy defined by pecuniary or nonpecuniary returns and tend to progress up this

[1]For example, less than 5 percent of all changes in assignment within the San Diego School District between the 1970-71 and 1971-72 school years involved a vertical rather than a horizontal move. Greenberg and McCall, *Teacher Mobility in San Diego*, 1973.

hierarchy as they gain teaching experience, labor markets for teachers must be considered manorial.

Movements within an internal labor market may be either voluntary or involuntary. Presumably movements up the assignment hierarchy are mostly voluntary; they result when a teacher compares available alternatives and selects the most attractive from among these. Examples of involuntary movements are intra-district transfers because of performance problems or to fill open slots, such as at newly established schools.

Although in practice the distinction is not always clear-cut, exits from an internal market may also be voluntary or involuntary. Involuntary mobility includes dismissals and mandatory retirements. Voluntary mobility is on the basis of a comparison of available alternatives. Examples are a college student who selects teaching from among several potential occupations, a new college graduate who selects a particular school system from among several possibilities, and a teacher who terminates to take a job elsewhere or to engage in some other activity (travel or child rearing, for example).

HUMAN CAPITAL

The understanding of labor mobility has been greatly enhanced by human capital considerations.[1] One of the major contributions of human capital theory is the recognition that each individual has embodied within him a valuable economic resource called "human capital," yielding returns over his entire lifetime. Investments in human capital include formal education, vocational training, on-the-job training, health care, migration, and information accumulation. The distinction between general and specific human capital is a key factor in understanding labor mobility. General human capital encompasses all those investments that bring the same return in all occupations. Specific human capital comprises those investments in human capital having a higher return in one occupation, or even in one specific teaching assignment, than in any other. In the limiting case, specific human capital has a positive return in only one occupation or assignment and is useless elsewhere. Learning the best travel route from home to job is an example of human capital that is specific to a particular company or school.[2]

The concept of specific human capital is relative. Knowledge of the idiosyncrasies of a certain employer is a form of human capital specific to that firm. It is, however, general human capital with respect to alternative assignments within that firm. Information about the organizational peculiarities of a particular industry is specific human capital with respect to that industry, but it is general human capital in a comparison of two assignments within that industry. A master's degree in education is specific human capital to the education sector. However, it is general human capital when two jobs within the education sector are being evaluated.

[1]For a complete description of the theory of human capital, see Gary Becker, *Human Capital*, Columbia University Press, New York, 1969.

[2]Like the internal labor market theory, the human capital theory is applicable to almost all sectors of the economy, including education. To illustrate the general applicability of the theoretical principles we are discussing, we shall frequently use generic terms such as "company," "industry," "worker" and "employer." The corresponding terms specific to education, such as "school district," "education sector," "teacher" or "principal," should be obvious in most cases.

Large investments in specific human capital impede movement from the set of jobs for which the investments are specific. The cost of such moves is the loss or diminution of a valuable asset. Similarly, movement into this set of jobs is inhibited by specific human capital requirements.[1] It is precisely these barriers to mobility that partition labor markets into relatively autonomous submarkets--that is internal labor markets. If a firm undertakes specific human capital investment in employees, it will be reluctant to fire these employees in periods of slack product demand. If the employees bear these investment costs, they will be unwilling to accept what superficially appear to be higher wage offers by other firms.[2] On closer inspection these outside offers are inferior precisely because they do not compensate for the present value of earnings forgone on firm-specific investments; that is, the present value of these offers is lower than the present value of earnings from the firm in which specific human capital investments have been made.

Illustrations of these human capital considerations are readily found within education. For example, an experienced teacher with graduate degrees in education is less likely to leave the education sector for a job elsewhere than an individual with a smaller investment in teaching. Likewise, a teacher who has acquired extensive knowledge about a specific school district is less likely to move to another relatively unknown district. And movements within a school district are more likely to be made by teachers with only modest investments in human capital that are specific to a single school in the district.

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[1]These impediments to mobility have been recognized by many economists and operations researchers. See Becker, 1964; C. Holt, F. Modiglianai, J. Muth, and H. Simon, *Planning Production, Inventories and Work Force*, Prentice-Hall, Englewood Cliffs, N.J., 1961; and Walter Oi, "Labor as a Quasi-Fixed Factor," *Journal of Political Economy*, Vol. 70, December 1962, pp. 538-555.

[2]These hypotheses were tested in D.O. Parsons, "Specific Human Capital: An Application to Quit Rates and Layoff Rates," *Journal of Political Economy*, Vol. 80, November/December 1972, pp. 1120-1143. His result was that "the important static implication that average quit and layoff rates will be lower, *ceteris paribus*, in industries where worker- and firm-financed specific investments are heavy, received strong support."

Such barriers to mobility partition the educational sector into numerous internal labor markets. These internal labor markets exist at three different conceptual levels. The most general concept of an educational internal labor market embraces the entire primary and secondary teaching sector. At this level of generality the external labor market consists of all nonteaching occupations. Considerable diversity characterizes the operation of this internal labor market. Nevertheless, the hierarchical structure is sufficiently homogeneous and the human capital barriers to entry and exit sufficiently strong to justify this interpretation. Indeed, although this internal labor market is the most heterogeneous of the three, the barriers to entry and exit are probably strongest. Furthermore, districts often facilitate inter-district movement by taking account of teaching experience gained elsewhere in determining salaries. Entrants to this market are recent college graduates and former teachers returning from other occupations, housekeeping being the most prominent. Departures are made by retiring teachers and those who decide to pursue nonteaching occupations.

The overall teachers' market is divided into internal labor markets associated with particular school districts. All other school districts are now included in the external labor market. Although these school districts do have analogous hierarchical structures, the flow of teachers across districts is obstructed by investments in human capital that are specific to a single district. We contend that the segmentation of school districts into separate markets is explicable by investments in specific human capital. These investments are primarily informational--teachers learn the idiosyncrasies of the school system and identify schools with good principals and good students. This segmentation is frequently reinforced by the secondary effects of specific human capital. For example, the vesting provisions of district retirement plans impede movement across districts.[1] State credential requirements have a similar effect.

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[1] "Although quits and layoffs are influenced by considerations other than investment costs, some of these, such as pension plans, are more strongly related to investments than may appear.... A pension plan

An internal labor market also exists at the individual school level. Every occupation outside this school is in the external labor market. Once again it is investments in human capital specific to the school that create barriers to movement between the internal and external markets. From the general internal labor market of the teaching sector to that of the individual school, there is a progressive tendency for the barriers to mobility to weaken.

A MODEL OF JOB SEARCH AND CAREER CHOICE

Internal labor markets and the theory of human capital are complementary rather than competitive explanations of labor mobility. Traditional demand and supply analysis of labor markets is unable to account completely for the mobility patterns of workers among jobs. Individual characteristics limit the internal labor market in which job search occurs. Furthermore, the accumulation of experience and training place additional constraints on the set of feasible jobs. Thus the segmentation of labor markets becomes more pronounced as the worker gains job-specific experience. Job opportunities that would have been acceptable in the worker's youth are no longer viable because of the nontransferability of his accumulated human capital. Therefore, quit rates should decline with age. Correspondingly, employers are more dependent on employees who have obtained specific training at the firm's expense, so layoffs should also decline with an employee's age.

Consider a young person in the process of making a career choice. The variety of alternatives available to him will be conditioned by his interests and abilities. Presumably, at this early stage he will possess only vague information about differences in career returns

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with incomplete vesting privileges penalizes employees who quit before retirement and thus provides an incentive...not to quit. At the same time pension plans insure firms against quits for they are given a lump sum--the nonvested portion of payments--whenever a worker quits. Insurance is needed for specifically trained employees because their turnover would impose capital losses on firms. Firms can discourage such quits by sharing training costs and the return with employees, but they would have less need to discourage them and would be more willing to pay for training costs if insurance were provided. The effect on the incentive to invest in one's employees may have been a major stimulus to the development of pension plans with incomplete vesting." Becker, 1964, pp. 26-27.

(pecuniary and nonpecuniary). The following is a very simple model in which there are search costs and returns associated with each career choice.

A stochastically independent job offer, x, is obtained each period, where x is a random variable with probability density function $\phi_i(x)$ when the person searches within the ith career--that is, ϕ_i is the return density function for jobs located in the ith career. The job searcher is assumed to accept the highest job offer[1] so that the return, Y_n, from stopping after the nth period of search is given by

$$Y_n = \max(x_1,\ldots,x_j,\ldots,x_n) - nc_i \ ,$$

where c_i is the cost per period of search in the ith career, including transportation costs, the psychic costs of rejection, and the value of forgone alternatives; and x_j is the offer obtained in the jth period.

If the distribution ϕ_i is known, the optimal search procedure is easy to determine. After n periods, the costs of search, nc_i, have already been spent, so that in deciding whether to continue, the searcher need only consider whether his present best offer, m, is within c_i of the expected value of one more search. Since that depends only on m, the rule for searching is to stop when m is larger than a certain number and keep searching if it is smaller than that number. That number, ξ_i, is the value of m for which an individual is indifferent between continuing and stopping.[2] Thus, the optimal policy

[1] If $\phi(x)$ is known by the job searcher, there is no difference in the analysis between assumption of retaining the highest of past job offers and the assumption of retaining only the last offer. If $\phi(x)$ is not known for sure, these two assumptions do give different results. Here the job offer should be interpreted as the discounted expected value of a particular employment opportunity in the ith career.

[2] Formally, ξ_i is the solution to

$$\xi_i = \xi_i \int_0^{\xi_i} \phi_i(x)dx + \int_{\xi_i}^{\infty} x\phi_i(x)dx - c_i \ ,$$

has the form:

$$\begin{array}{ll} \text{Continue searching} & \text{if } m < \xi_i \,, \\ \text{Accept employment} & \text{if } m \geq \xi_i \,. \end{array}$$

Following this procedure, the young decisionmaker calculates the expected discounted return of the k careers for which he is contemplating entry--that is, the vector $(\xi_1, \xi_2, \ldots, \xi_k)$ is calculated. At this early stage, the vagueness of the decisionmaker would be displayed in the bunching of the ξ_i's. This bunching would also be anticipated on purely economic grounds; competition among entrants would tend to erode differences in career returns. In particular, the maximum ξ_i, say ξ_s, is probably not much higher than the second best return. However, assume that a choice is made and the individual begins training for career s. Soon after choosing s, he may decide he has made a mistake and switch to some other career. Indeed, experimentation and sorting out would be anticipated early in the career choice process when specific investments are small. After some experimentation, the individual decides on a particular career, say the pth, and pursues it for some time. Now he reconsiders his career choice. The cost of search, c, in other careers will now be higher than before because of the earnings (in p) forgone during search, and his productivity in p as reflected by ϕ_p should be large relative to other careers. It follows that ξ_p is likely to be much higher than the expected return on the second best career choice and the probability of departure from p should be relatively small.

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or equivalently, since $\int_0^\infty \phi_i = 1$,

$$c_i = \int_{\xi_i}^{\infty} (x - \xi_i)\phi_i(x)dx.$$

The mobility of individuals among careers, therefore, should diminish with age and experience in a very natural way.[1] Analogous impediments to job mobility will emerge as individuals become more experienced in particular jobs within a given career. Similarly, if large investments in specialized training or other forms of specific capital must be made to obtain entry to a particular career or job, persons are less likely to transfer into that career or job. The larger the investment in a given career or job, the less likely a person is to move into or out of it. It is these investments that partition markets into highly visible internal labor markets.[2] These internal labor markets are definable only with respect to a specific class of individuals; the barriers to entry and exit depend on the individual's experience profile. Only in exceptional cases will workers quit jobs in which they have accumulated much skill and enter other jobs with completely different but also substantial skill requirements.

The same sort of market segmenting forces are also operative on the employer side. For a given wage offer, let the employer's cost of search, the marginal product he obtains by stopping search, and the probability density function of marginal products be denoted by k, y, and ψ, respectively. By an analysis similar to that of career choice by employees, the optimal search strategy for the employer is:

$$\begin{array}{ll} \text{accept applicant} & \text{if } y \geq \eta \\ \text{reject applicant} & \text{if } y < \eta \ , \end{array}$$

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[1]Empirical studies tend to confirm this implication. For example, see I. Blumen, M. Kogan, and P. J. McCarthy, *The Industrial Mobility of Labor as a Probability Process*, Cornell University Press, 1965.

[2]For an alternative theory of occupational mobility see S. Rosen, "Learning and Experience in the Labor Market," *Journal of Human Resources*, Vol. 7, Summer 1972, pp. 326-342.

where η is the value for y such that the employer is indifferent between continuing to search and stopping.[1]

Suppose the population from which the employer can search is decomposable into n subgroups on the basis of such easily measured characteristics as age, experience, and education. Let k_i, y_i, and ψ_i be the cost of search, the marginal product, and the probability density function of the ith subgroup. Using these values, the employer solves the equation just presented for η_i, $i = 1,\ldots,n$. The employer then searches within the subgroup with the highest marginal product, η_i.[2] This subgroup will have experience that is commensurate with the job requirements or will be best able to acquire job-specific experience and young enough so that such an investment will have a long payout period. The employer will probably not search within subgroups that have large accumulated human capital specific to other jobs. Ultimately, it is the interaction of the search strategies of employers and employees that generates internal labor markets.

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[1]Formally, η is the solution to $k = \int_{\eta}^{\infty} (y - \eta)\psi(y)dy = G(\eta)$.

[2]This model is consistent with the frequently suggested notion that labor markets operate as queues. According to this concept workers and potential workers queue up in order of their relative attractiveness to employers, with relative attractiveness determined by such factors as education, experience, age, race, and sex. The distance employers reach back into the queue is presumed to depend on the number of job openings. The concept of the labor market as a queue apparently was first presented in *Technology and the American Economy*, Report of the National Commission on Technology, Automation, and Economic Progress, Washington, D.C., February 1966.

A MARKOV MODEL OF LABOR MOBILITY

Probabilistic models of labor flows are a third approach to the understanding of labor turnover. These models are easily integrated with the human capital and internal labor market approach. For example, Markovian models can be used to describe mobility within a given internal labor market when transitions to other internal labor markets are permitted, but moves become increasingly unlikely as the worker accumulates on-the-job training. Imbedding the human capital and internal labor market construct within a Markov transition matrix is also a natural step to take in moving from theory to hypothesis testing. Almost all of the hypotheses about labor mobility can be specified as relationships between transition probabilities and job characteristics, employee characteristics, and adjustment costs.

A Markov chain is a dependent stochastic process. The basic assumption is that the transition probability, $P_{ij}(t)$, of an individual moving from teaching assignment i in period t to assignment j in period t + 1 is not influenced by his behavior before period t. The future manifestations of a Markov chain are treated as completely determined by the present state of the system--that is, as independent of the past.

In formal terms, the stochastic process X(t) is a Markov chain if X(t) assumes only a finite number of values as t runs over the positive integers *and* the following condition (Markov property) is satisfied:

$$P\{X(t_n) = x_n | X(t_1) = x_1, \ldots, X(t_{n-1}) = x_{n-1}\}$$

$$= P\{X(t_n) = x_n | X(t_{n-1}) = x_{n-1}\} .$$

The conditional probabilities, $P\{X(t_n) = j | X(t_{n-1}) = i\} = P_{ij}(t)$ are called the transition probabilities of the Markov chain. If the transition probabilities are independent of t, $P_{ij}(t) = P_{ij}$, for all t, the chain is said to be *stationary*.

ENTRY TO AND EXIT FROM THE TEACHING SECTOR

The properties of Markov chains and their usefulness in the analysis of the movement of labor to and from teaching can best be illustrated by a simple two state example with stationary transition probabilities. Suppose that an employee chooses one of two labor markets, teaching (T) or nonteaching (N). If an employee is teaching in the nth period, the probability of his transiting to nonteaching in period n+1 is p_1; if an employee is in a nonteaching occupation in period n, the probability is p_2 that he will move to the teaching section in period n+1. Let X be a random variable denoting the state of the system at period n. Employment in teaching (nonteaching) corresponds to the state $X_n = 0 (X_n = 1)$. The transition probabilities of this two state model are:

$$P(X_{n+1} = 1 | X_n = 0) = p_1$$

$$P(X_{n+1} = 0 | X_n = 0) = 1 - p_1 = q_1$$

$$P(X_{n+1} = 1 | X_n = 1) = 1 - p_2 = q_2$$

$$P(X_{n+1} = 0 | X_n = 1) = p_2 \;.$$

The transition probabilities of a Markov chain can be compactly described by the transition probability matrix.

$$P = \begin{array}{c c} & \begin{array}{cc} 0 & \quad 1 \end{array} \\ \begin{array}{c} 0 \\ 1 \end{array} & \begin{pmatrix} 1 - p_1 & p_1 \\ p_2 & 1 - p_2 \end{pmatrix} \end{array} .$$

In general, these transition probabilities depend on such teacher characteristics as experience, educational attainment, and sex. The first two of these are indicative of a teacher's investment in human capital that is specific to teaching, and the third reflects the well-known tendency of women to enter and leave the labor force with greater frequency than men. The mobility of these different demographic groups can be studied separately by constructing a Markov matrix for each relatively homogeneous group.

Initially, the probabilities of employment in teaching and nonteaching are

$$P(X_0 = 0) = \pi_0(0)$$

and

$$P(X_0 = 1) = \pi_0(1) = 1 - \pi_0(0),$$

respectively. The initial distribution of the chain can be compactly represented by the vector

$$\pi_0 = (\pi_0(0), \pi_0(1)).$$

Given the initial probability distribution π_0 and the stationary transition matrix P, the probabilities of employment in teaching and nonteaching can be calculated for any future period n.

In matrix notation, the distribution $\pi_n = (\pi_n(0), \pi_n(1))$, of the Markov chain at the nth period is given by

$$\pi_n = \pi_{n-1}P,$$

which on iteration reduces to

$$\pi_n = \pi_0 P^n ,$$

where P^n is the matrix of n step transition probabilities. The (i, j) entry of P^n, say $p_{ij}^{(n)}$, is simply

$$p_{ij}^{(n)} = p(X_n = j | X_0 = i) .$$

A Markov chain is said to be *regular* if *some* power of the Markov transition matrix is composed of only strictly positive elements. When the Markov chain is regular, an equilibrium or steady state probability distribution exists and is the solution to

$$\pi = \pi P ,$$

subject to

$$\sum \pi(i) = 1 .$$

In the two-state example, this reduces to a system of three equations with two unknowns that under the assumptions made has the following solution:

$$\pi(0) = \frac{p_1}{p_1 + p_2}$$

and

$$\pi(1) = \frac{p_2}{p_1 + p_2} .$$

In a study of teacher mobility, the equilibrium distribution associated with a particular Markov transition matrix can be interpreted as the proportion of employees who will be teaching at some future time if labor mobility is regulated by that particular transition matrix. By its immediate indication of long-run effects, the equilibrium distribution is a convenient measure of the feasibility and desirability of a specific transition matrix. If the long-run behavior is unacceptable, different methods could be considered for altering the transition matrix. The choice among these different methods is again facilitated by studying their implications in terms of the equilibrium distribution.

INTER-DISTRICT TEACHER MOBILITY

In discussing human capital concepts, we argued that the barriers to mobility among internal labor markets justify their separate analysis There are several ways to measure the imperviousness of these barriers within the Markovian setting. One is to simply calculate the transition probabilities for movements from one internal labor market to another. Large values of these transition probabilities would be indicative of porous barriers; there would be only small differences in the specific human capital requirements of the two markets. In fact, one could argue that if the barriers are sufficiently porous, there really are no separate internal markets. Another indication of the vitality of a particular internal labor market is the proportion of retirees--persons leaving the labor force--among those who leave the market; the higher this proportion, the stronger the market. One easy way of calculating this proportion directly from the probability transition matrix is to partition the state space of the Markov chain into three mutually exclusive groups: states in this internal labor market, states in other internal labor markets, and retirement. If we assume that an individual who retires never reenters this labor market and that individuals who exit to other internal labor markets almost never return, then retirement is an "absorbing state,"[1] and the set of states in other internal labor markets constitutes an absorbing set. The remaining states are "recurrent." The probability of being absorbed in the set of outside jobs can be compared to the absorption probability of retirement.[2]

These techniques should be particularly useful in an examination of the movement of teachers among school districts. In theory a detailed Markov model could be constructed for all primary and secondary school districts, but such a model would be exceedingly cumbersome and difficult to analyze. A more practical approach is to build a skeleton Markov model for the school districts under investigation. These districts could then be lumped into several district sets based on their commonality with respect to teacher mobility. For example, if teachers do not move between districts i and j, these districts should be placed in different sets; if the mobility between i and j is above some critical level, the districts should be members of the same set. The human capital theory discussed earlier gives *a priori* guidance as to how these decompositions might look. Urban districts or contiguous districts are more likely to be members of the same set than are districts with very different features. A teacher will presumably look for a district that possesses many familiar attributes, transferring as much of his experience as possible.

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[1]Women who temporarily leave the labor force but eventually return to teaching must be considered as having entered a separate state; that is, housekeeping is usually not an "absorbing" state.

[2]For details, see P. G. Hoel, S. C. Port, and C. J. Stone, *Introduction to Stochastic Processes*, Houghton Mifflin Company, Boston, 1972.

As suggested in the previous footnote, in estimating the absorption probability of retirement one must be careful not to count as "retired" women who have temporarily left teaching in order to raise a family.

Suppose it does appear sensible to group districts into urban and nonurban sets. How might Markov methodology be used to study the nature of teacher movements between these two sets of districts? For illustrative purposes let us assume that teachers are initially evenly divided between the two types of districts and that the transition matrix between the urban (U) and nonurban (N) districts is given by:[1]

$$P = \begin{array}{c c} & \begin{array}{cc} U_{t+1} & N_{t+1} \end{array} \\ \begin{array}{c} U_t \\ N_t \end{array} & \begin{pmatrix} 7/10 & 3/10 \\ 2/10 & 8/10 \end{pmatrix} \end{array} .$$

For this hypothetical Markov matrix, the long-run proportion of experienced teachers in urban districts is

$$\pi_1 = \frac{2/10}{3/10 + 2/10} = 2/5 ,$$

and the long-run proportion of experienced teachers in nonurban districts is

$$\pi_2 = \frac{3/10}{3/10 + 2/10} = 3/5 .$$

This Markov methodology can be used to measure the influence of alternative policies on teacher retention in urban districts. Suppose that by increasing salaries, reducing class sizes in urban districts, or altering some other control variable, the transition matrix P could be changed to

$$P' = \begin{array}{c c} & \begin{array}{cc} U_{t+1} & N_{t+1} \end{array} \\ \begin{array}{c} U_t \\ N_t \end{array} & \begin{pmatrix} 8/10 & 2/10 \\ 3/10 & 7/10 \end{pmatrix} \end{array} .$$

[1] For simplicity, we do not consider entry to and exit from teaching in this illustrative example. A complete Markov model of teacher

The long-run proportion of experienced teachers in urban districts would be increased from

$$\pi_1 = 2/5 \text{ to } \pi_1' = 3/5 \text{ .}$$

Correspondingly, the long-run proportion of experienced teachers in nonurban districts would be reduced from

$$\pi_2 = 3/5 \text{ to } \pi_2' = 2/5 \text{ .}$$

Whether or not such a change should be implemented depends on the cost of changing the control variables relative to the benefits derived from the modified steady-state proportions.

INTRA-DISTRICT TEACHER MOBILITY

The mobility of employees *within* a hierarchical internal labor market, such as a single school district, can also be studied with Markov chains.[1] For example, consider a school system in which there are ℓ distinct teaching levels. Occupancy in a specific level is determined by a teacher's experience, educational attainment, and achievement. Typically, new teachers entering the system might begin at the lowest level, 1, and gradually move up through the system, ℓ being the highest level achievable.[2]

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mobility must, of course, explicitly consider all aspects of mobility within a single system. A birth and death stochastic process would be one way of analyzing the entire system. *Ibid.*

[1]Markovian methods can be used to examine either hierarchical or lateral movements within an internal labor market. This discussion, however, explicitly considers the manorial (that is, hierarchical) component of a school district's internal labor market. As we indicated earlier, although most moves by teachers within an internal labor market are formally horizontal, many of these moves may actually be along an informal vertical structure since it seems reasonable to expect teachers to move toward assignments offering them the greatest pecuniary and nonpecuniary returns.

[2]This example is equally applicable to movement up the formal educational hierarchy (e.g., a promotion from teacher to principal) and to movement up an informal hierarchy (e.g., a transfer from a school

Let $n_i(t)$ be the total number of teachers at level i during period t. The total number of teachers in the system at time t is

$$N(t) = \sum_{i=1}^{\ell} n_i(t) .$$

A teacher who was at level i in period t moves to level j in the subsequent period with probability p_{ij}. Of course, at any time a teacher may leave the system to join another school system or to retire from teaching. Let $\ell + 1$ denote this departure state. Then between periods t and t + 1, a teacher can move along $\ell + 1$ states (remaining at the current level is considered a move). It follows that

$$\sum_{j=1}^{\ell+1} p_{ij} = 1 ,$$

where the probability of departure is given by

$$p_{i,\ell+1} = 1 - \sum_{j=1}^{\ell} p_{ij} .$$

Most teachers entering a school district are inexperienced and will, therefore, begin at level 1. However, since lateral movements among districts are permitted, it is possible for a teacher to enter at a higher level. Let P_{0j} be the probability that an entering teacher is assigned to the jth level. Then

$$\sum_{j=1}^{\ell} p_{0j} = 1 .$$

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most teachers find undesirable to a school they prefer). The first type of movement will generally result in an improvement in both pecuniary and nonpecuniary returns; the second usually brings about an improvement only in nonpecuniary returns.

The number of new teachers entering the system at t, $n_0(t)$, is a random variable. These entering teachers are distributed among the ℓ states according to the vector $(p_{01},\ldots,p_{0\ell})$.

For given values of the transition probabilities, number of entrants, and initial number of teachers at each level, the future of this system can be predicted. For example, the calculation of the expected number of teachers at each level during any future period is straightforward.[1]

This procedure may be illustrated by reference to a recent study of teacher mobility among schools within the San Diego School System.[2] Schools within this system were divided into two subsectors on the basis of the performance of their students on standardized reading tests: Those scoring in the lowest one-third were assigned to the low subsector, and the highest two-thirds were assigned to the high subsector. During the 1970-71 school year, 65.5 percent of all ordinary school teachers were in the high subsector, and 34.5 percent were in the low subsector. The assumption was that teaching in the high subsector was ranked higher in the assignment hierarchy by most teachers than teaching in the low subsector.

The movement of teachers between these two subsectors from 1970-71 to 1971-72 is summarized by the Markov transition matrix presented in Table 1. The matrix has the following interpretation: The probability of a teacher in the high subsector moving to the low subsector between 1970-71 and 1971-72 was .014, and the probability of remaining in the high subsector was .986; the probability of teachers in the low subsector moving to the high subsector was .053, and their probability of staying was .947. Thus, the probability of staying in one's initial subsector between school years is much greater than the probability of moving. Nevertheless, among those who do move, the chances of going

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[1] For details see D. J. Bartholomew, *Stochastic Models for Social Processes*, John Wiley and Sons, New York, 1967.

[2] See D. Greenberg and J. McCall, *Teacher Mobility in San Diego*, 1973.

Table 1

TRANSITION MATRIX FOR SAN DIEGO SCHOOL TEACHERS

	1971-72	
1970-71	High Subsector	Low Subsector
High subsector	.986	.014
Low subsector	.053	.947

from the low to the high subsector is almost four times greater than the chances of moving in the opposite direction.[1]

Over the years, if the probabilities constituting the transition matrix do not change, the proportion of teachers now in the San Diego School System who will be at schools in the high subsector will steadily increase. The net outcome is described in Table 2. After five years

Table 2

CHANGES IN THE INITIAL DISTRIBUTION OF TEACHERS WHEN MOBILITY IS GOVERNED BY THE MATRIX IN TABLE 1

Period[a]	Percent in the High Subsector	Percent in the Low Subsector
0	65.5	34.5
1	66.4	33.6
2	67.3	32.7
3	68.1	31.9
4	68.8	31.2
5	69.5	30.5
10	72.3	27.7
15	74.3	25.7
20	75.7	24.3
∞	79.2	20.8

[a]Period 0 represents the 1970-71 school year, period 1 represents the 1971-72 school year, and so on.

[1]Approximately half of this difference is because there are about twice as many assignments in the high subsector as in the low subsector.

the proportion of teachers in the high subsector has risen from .655 to .695, with a corresponding decline in the proportion of teachers in the low subsector. The proportion of teachers in the high subsector increases to .757 after 20 years. And if the transition matrix presented in Table 1 is allowed to operate indefinitely, this proportion achieves a steady-state value of .792; that is, 79.2 percent of the teachers who were in the San Diego School System in 1970-71 and who remain within that school system will be in the high subsector, and only 20.8 percent will be in the low subsector.

Table 2 is based on the assumption that the probabilities in the transition matrix will be unchanged. However, if one can reasonably predict changes in these probabilities, one can readily calculate the consequences of these changes.[1] Furthermore, if the distributional outcomes implied by Table 2 are considered undesirable, Markov analysis could be used to help evaluate policies to change the underlying probabilities.

In concluding the discussion of the Markov model it may be useful if we reiterate the advantages of this technique for analyzing labor mobility. (1) It is easy to formulate the labor mobility process as a Markov chain. (2) The economic determinants of labor mobility can be entered as arguments in the transition probability functions. (3) Reformulation of the economic hypotheses, such as those implied by the internal labor market and human capital models, in the Markovian setting leads directly to empirical testing. The hypothetical effects of experience, education, and the like on labor mobility are conveniently specified by the transition probability functions. (4) Finally, in addition to facilitating the positive analysis of labor mobility, one also can readily conduct predictive and normative analyses with Markov chains.

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[1] See Leo Breiman, *Probability and Stochastic Processes*, Houghton Mifflin, Boston, 1969.

SOME IMPLICATIONS OF THE THEORY OF TEACHER MOBILITY

The following is a list of hypotheses that are immediate consequences of the theory of teacher mobility. All these should be readily testable with available data on teachers.[1] Although we feel these hypotheses are interesting and important, they are only meant to be suggestive; others will undoubtedly occur to the interested reader.

1. Inter-district movement of school teachers should depend on both pecuniary and nonpecuniary differences among districts. Pecuniary returns are measured in terms of salary, and the nonpecuniary returns should depend on nonsalary factors that affect a teacher's perception of a district's attractiveness--for example, the district's geographic location, physical facilities, and the socioeconomic background of its students. Thus, teachers should be observed moving from relatively unattractive districts with low pay to relatively attractive districts with high pay.

2. Since teaching assignments *within* a particular school district usually do not differ in terms of salary, the internal movements of teachers will be partially based on nonpecuniary differences, but not on pecuniary differences. In particular, teachers should tend to move from relatively unattractive district schools to relatively attractive schools.

3. Since teachers should acquire human capital that is specific to given districts, barriers to moves between assignments in different districts should be greater than barriers to moves between assignments in the same district. Thus, intra-district mobility should exceed inter-district mobility. The probability of making an inter-district move should be inversely related to opportunities that are available for making intra-district moves. For example, teachers in large districts with many schools should tend to make intra-district transfers, and teachers in smaller districts should tend to transfer between districts.

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[1] See, for example, Greenberg and McCall, *Teacher Mobility in San Diego*, 1973; and Greenberg and McCall, *Teacher Mobility in Michigan*, 1973, for a discussion of such data and preliminary tests of most of the hypotheses listed below.

4. Teachers who are located in assignments offering relatively low pecuniary or nonpecuniary returns should be more likely to leave teaching than those in more attractive assignments. This will be particularly true if, because of depressed market conditions for teachers or for some other reason, there is little opportunity to obtain more satisfactory assignments through intra- or inter-district transfers.

5. We would expect school districts to prefer to hire teachers who have teaching experience and advanced degrees in education. For one thing, districts may be able to obtain more information about experienced teachers than inexperienced teachers. Teachers, however, prefer districts offering the highest returns. Consequently, inexperienced teachers with relatively low educational attainment should tend to locate in relatively unattractive districts that offer them relatively low salaries. Once hired, these new teachers should tend to be assigned to the least attractive schools within the district because newly hired teachers have the least knowledge of the school system--an investment in specific human capital--and as outsiders have the least control over the allocation of opportunity within the internal labor market.

6. Relatively experienced teachers should be less mobile than less experienced teachers because they are more likely to be located in an assignment they consider attractive. Teachers search for and eventually find an assignment they consider attractive. Moreover, their investment in the human capital specific to their particular assignment is likely to be relatively larger than that of teachers with less experience.

7. A consequence of the preceding hypotheses is that the more attractive schools should tend to have faculties with relatively greater experience (and probably greater educational attainment) than the less attractive schools. Similarly, high salary, relatively attractive school districts should possess faculties with greater experience and educational attainment than the less well-endowed districts. Among school districts, however, there is a tradeoff between salary and status that should be examined. Districts that

offer low nonpecuniary returns may be able to attract experienced, highly educated teachers by offering higher salaries. The precise relationship between pecuniary and nonpecuniary returns needed to attract teachers is a separate issue very much worth investigating.

8. Teachers with a relatively high number of college semester hours should be less likely to leave teaching than those with a low number because teachers with many semester hours above the bachelor's degree have made a considerable investment in specific human capital for which the highest return is obtained by remaining in teaching. This specific human capital should impede movement to the nonteaching sector. Similarly, young teachers, with relatively little experience and, hence, a relatively small investment in specific human capital, should be more likely to terminate.[1] Since females generally have greater opportunities to engage in useful activities outside the labor force than males, female teachers should be more likely to terminate.

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[1]Teachers who terminate to retire would, of course, be relatively older and more experienced.